IDENTIFICATION OF DEVELOPMENTAL DYSGRAPHIA BY HANDWRITING ANANLYSIS

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TO WHOM IT MAY CONCERN

I hereby recommend that the Project entitled **IDENTIFICATION OF DEVELOPMENTAL DYSGRAPHIABY HANDWRITING ANANLYSIS**

preparedunder my supervision by **Abhimanshu Kumar** (Reg. No. 141170110001, Class Roll No. CSE2014/063),**Richa Sinha** (Reg. No. 141170110048, Class Roll No. CSE2014/083), **Satyam Garodia** (Reg. No. 141170110062, Class Roll No. CSE2014/080), **ShaluKumari** (Reg. No. 141170110064, Class Roll No. CSE2014/064) of B.Tech (8th Semester), may be accepted in partial fulfillment for the degree of **Bachelorof Technology inComputer Science& Engineering** under West Bengal University of Technology(WBUT).

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CERTIFICATE OF APPROVAL

The foregoing Project is hereby accepted as a credible study of an engineering subject carried out and presented in a manner satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein, but approve the project only for the purpose for which it is submitted.

FINAL EXAMINATION FOR
EVALUATION OF PROJECT

1. ——————————————

2. ——————————————

(Signature of Examiners)

ACKNOWLEDGEMENT

The satisfaction that accompanies the progress of this work would be incomplete without the mention of the people who made it possible, without whose constant guidance and encouragement would have made efforts go in vain. I consider myself privileged to express gratitude and respect towards all those who guided us through the considerable progress of this project.

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1. Introduction

Dysgraphia is a specific learning disability that affects written expression.

Dysgraphia can appear as difficulties with spelling, poor handwriting and trouble putting thoughts on paper. Dysgraphia can be a language based, and/or non-language based disorder.

Many people have poor handwriting, but dysgraphia is more serious. Dysgraphia is a neurological disorder that generally appears when children are first learning to write. Experts are not sure what causes it, but early treatment can help prevent or reduce problems.

Writing requires a complex set of motor and information processing skills. Not only does it require the ability to organize and express ideas in the mind. It also requires the ability to get the muscles in the hands and fingers to form those ideas, letter by letter, on paper.

Dysgraphia that is caused by a language disorder may be characterised by the person having difficulty converting the sounds of language into written form or knowing which alternate spelling to use for each sound. A person with dysgraphia may write their letters in reverse, have trouble recalling how letters are formed, or when to use lower or upper case letters. A person with dysgraphia may struggle to form written sentences with correct grammar and punctuation, with common problems including ommitting words, words ordered incorrectly, incorrect verb and pronoun usage and word ending errors. People with dysgraphia may speak more easily and fluently than they write.

SOME SIGNS OF DYSGRAPHIA

- Generally illegible writing
- Inconsistencies in writing, e.g. mixtures of printing and cursive writing,etc
- Unfinished words or letters, omitted words
- Inconsistent position of letters on the page with respect to lines and margins
- Inconsistent spaces between words and letters
- Strange wrist, body, or paper position
- Talking to self whilst writing, or carefully watching the hand that is writing
- Slow or laboured copying or writing
- Large gap between written ideas and understanding demonstrated through speech.
- Difficulty organising thoughts on paper

CLASSIFICATION

Dysgraphia is nearly always accompanied by other learning differences such as dyslexia or attention deficit disorder, and this can impact the type of dysgraphia a person might have. There are three principal subtypes of dysgraphia that are recognized. There is little information available about different types of dysgraphia and there are likely more subtypes than the ones listed below. Some children may have a combination of two or more of these, and individual symptoms may vary in presentation from what is described here.

Most common presentation is a motor dysgraphia resulting from damage to some part of the motor cortex in the parietal lobes.

Dyslexic

People with dyslexic dysgraphia have illegible spontaneously written work. Their copied work is fairly good, but their spelling is usually poor. Their finger tapping speed (a method for identifying fine motor problems) is normal, indicating that the deficit does not likely stem from cerebellar damage.

Motor

Motor dysgraphia is due to deficient fine motor skills, poor dexterity, poor muscle tone, or unspecified motor clumsiness. Letter formation may be acceptable in very short samples of writing, but this requires extreme effort and an unreasonable amount of time to accomplish, and it cannot be sustained for a significant length of time, as it can cause arthritis-like tensing of the hand. Overall, their written work is poor to illegible even if copied by sight from another document, and drawing is difficult. Oral spelling for these individuals is normal, and their finger tapping speed is below normal. This shows that there are problems within the fine motor skills of these individuals. People with developmental coordination disorder may be dysgraphia. Writing is often slanted due to holding a pen or pencil incorrectly.[2]

Spatial

A person with spatial dysgraphia has a defect in the understanding of space. They will have illegible spontaneously written work, illegible copied work, and problems with drawing abilities. They have normal spelling and normal finger tapping speed, suggesting that this subtype is not fine motor based.

2. Review of Literature

Handwriting, which is a required activity among school-aged children, involves both spatial and temporal demands (Amundson & Weil, 1996; Tseng & Chow, 2000).

Handwriting performance is considered to be proficient when legible text is produced at a minimum of effort. In this case, handwriting is automatic and does not interfere with the content as generated by the creative thinking process (Scardamailia, Bereiter, & Goleman, 1982). In contrast, poor handwriters are often unable to achieve a completely automated process, and their handwriting may be slow and unclear.Handwriting difficulty, or dysgraphia, was defined by Hamstra-Bletz and Blote (1993) as a disturbance or difficulty in the production of written language that is related to the mechanics of writing. Teachers have estimated that 11–12% of female students and 21–32% of male students have handwriting difficulties (Rubin & Henderson, 1982; Smits-Engelsman, Van Galen, &Michels, 1995).

Two main outcomes have been used to assess and define poor handwriting, namely,product readability or legibility and performance time. Product legibility has been evaluated in two ways:

(1) by judging the readability of an entire paragraph (Ayres, 1912; Freeman,1959),

Or

(2) by analytic methods based on grading specific features that characterize readability (e.g., between letter and word spacing, letter formation, the degree of line slant,etc.) and then calculating an overall score (see Rosenblum, Weiss, &Parush, 2003, for more details).

There are a number of reasons why current handwriting assessments are of limited value. First, their reliability is low to moderate; second, they require prolonged processing time by the evaluator who needs to judge the writing product for each of the legibility criteria and third, they do not provide substantive information about the writing process(Rosenblum et al., 2003, Rosenblum, Weiss, &Parush, 2004). The third reason poses a significant limitation, as it is believed that only a comprehensive description of the realtime, dynamic characteristics of a child's handwriting can provide insight into the motor control mechanisms of normal handwriting and an understanding of the underlying pathology of handwriting difficulties (Dobbie & Askov, 1995; Graham & Weintraub, 1996;LongstaV& Heath, 1997; Sovik, Arntzen, &Thygesen, 1987a, 1987b).

In recent years, more attention has been devoted to identifying the features of poor handwriting by children who have a variety of perceptual-motor and learning problems (e.g., Rosenblum, Parush, & Weiss, 2001; Rosenblum et al., 2003; Schoemaker& Smits-Engelsman, 1997; Smits-Engelsman, Van Galen, &Portier, 1994a; Smits-Engelsman,Niemeijer, & Van Galen, 2001). In most of these studies, children were asked to perform brief writing tasks (i.e., usually a single sentence). The testing of only brief writing tasks has limited ecological validity, since many clinicians and educators, as well as researchers, indicate that handwriting problems are particularly noticeable during the performance of tasks similar to those occurring in thechildren's natural learning environment (Rosenblum et al.,2003, 2004).

The term Dysgraphia is not widely used in schools. One reason is that handwriting difficulties can be included under the label of learning disabilities. Another reason is that there is no consensus in the field on one definition or identification process for dysgraphia. Richards (1999) defines dysgraphia as a problem with expressing thoughts in a written form. Meese (2001) describes dysgraphia as handwriting problems, specifically, a partial inability to remember how to make certain alphabet or arithmetic symbols. For the purpose of this paper, we are using the latter definition, and will be focusing on the mechanics of handwriting.

The treatment of dysgraphia can be elusive. Many instructional strategies have been proposed to help students with dysgraphia, but only some have empirical evidence to support them.

Teachers should be aware of the signs and symptoms of dysgraphia and not dismiss a child as simply having sloppy handwriting. If a teacher starts to see a trend of illegible writing, it is appropriate for them to question whether this child has dysgraphia. Teachers should note which parts of the writing process are most difficult for the child. While dysgraphia often occurs along with another dis-ability, many students with dysgraphia can exhibit high academic achievements in other subjects (Richards, 1999). Figure 1 shows an example of the handwriting of a second grade student with dysgraphia, and a typical second grader's handwriting. The characteristics of dysgraphia are varied and students can exhibit any one or more of these characteristics (see box, "Characteristics of Dysgraphia").

Feifer (2001) believes that dysgraphia can be categorized into four subtypes. The first subtype is phonological dysgraphia, that is "writing and spelling disturbances in which the spelling of unfamiliar words, nonwords, and phonetically irregular words are impaired" (p. 1). These students tend to have trouble spelling by sounds and rely on the visual aspect of letters; therefore, because spelling is an auditory task, they will have trouble with spelling tests. The second sub-type is surface dysgraphia where students have trouble with orthographic representations of words, which makes the student rely too heavily on sound patterns; the opposite of phonological dysgraphia. Mixed dysgraphia is the third subtype of dysgraphia. This type refers to students having trouble with mixing up letter formations and having trouble with spelling tasks, a combination of the first two types. Recalling letter formations is hard for these students to do because there are so many instructions or rules that they get con-fused and; therefore, have inconsistent spellings of words. Finally, semantic/syntactic dysgraphia is a grammatical problem in which students have difficulty with how words can be joined to make complete and comprehensive phrases.

In addition, children with dysgraphia usually have some type of problem with automaticity that interferes with the retrieval of letter formation (Richards, 1999). The con-centration on how to form the letter overwhelms the child to a degree that the letter is written poorly. Incorrect letter or word formation can also lead to exceeding the margins or lines. Letter formation is automatic for most students after initial skill attainment. When letter formation is automatic, students can concentrate on spelling, grammar, sentence structure, and other aspects of written language. However, for many students with dysgraphia, letter formation is a cognitive task which leaves little mental capacity to devote to these other aspects. Children with dysgraphia can become frustrated, leading to low motivation to use and practice written language.

Students concentrating too hard on letter formation may develop problems with gripping the pencil (Richards, 1999). A list of characteristics of a poor pencil grip can be seen in the box below. Gripping the pencil a "wrong" way can interfere with performance because the child focuses on holding the pencil instead of writing the letter. Richards (1998) suggested a proper pencil grip that included placing the fingers about one inchabove the tip of the pencil, maintaining a 45 degree angle with the paper, and using moderate pressure. Teachers should be aware of a child holding the pencil in an improper way and aim to correct the grip.

In addition to pencil grip and automaticity, retaining information in the working memory is not something most students have trouble mastering. Children with dysgraphia, however, often exhibit trouble with working memory because so much of their cognitive energy is put into the mechanical level of writing letters or words (Richards, 1999). It is similar to the seven plus or minus two phe-nomenon; the hypothesis that claims one can only hold seven items in memory plus or mi-nus two. For example, a social security number is nine items long. However, by clustering the nine digits into three groups, most people can easily recall their social security number. Children already have a limited number of spaces to hold information in memory and therefore have a harder time remembering many pieces of information. This study did not support the opinion that dysgraphia is a temporary developmental delayfor children. While this study did not involve an intervention, the researchers theorized that dysgraphia may be sensitive to training that addresses better movement strategies

One such remedial treatment is using drill and practice. Ediger (2002) suggested that the teacher should provide a clear example of good handwriting and then the children should practice and drill using the teacher's model. People with dysgraphia struggle with the display of letters because often the letter that is asked for in the brain is not the letter that is retrieved and produced (Richards, 1998). Repetitive practice, along with correct position and pencil grip can help with this process.

Another remedial treatment that has empirical evidence is building fine motor skills. Using drills that build the muscles used for fine motor activities can help improve hand functioning, which can lead to better handwriting (Berry, 1999). Keller (2001) used such activities in a club she created to help the handwriting of students with dysgraphia. Dikowski (1994) studied children's visual-motor skills related to handwriting. He found schools offered little help to students with handwriting or visual-motor disabilities. He observed that when children had visual-motor integration problems this led to problems with hand-eye coordination. Since the brain, hand, and eye all work together to per-form anything written.

IMAGE PROCESSING:-

Sight is a human being's principle sense. A visual image is rich in information from the outer world and receiving and analyzing such images is part of the routine activity of human beings throughout their walking lives. At a more sophisticated level, human beings may generate record or transmit images. These activities together comprise image processing.

Theories and techniques of image processing originated in the study of optics and optical instruments. However, the advent of digital computers opened vast new possibilities for artificial image processing. By the mid-1960's, third-generation computers offered the speed and s to r age necessary for practical implementation of image-processing algorithms; and in 1964 the capabilities of digital image processing were spectacularly demonstrated when pictures of the moon transmitted by the Ranger 7 space probe were processed to correct various types of image distortion inherent in the on-board television camera .Since that date, the field of image processing has experienced vigorous growth.

Digital image processing techniques are used today in a wide range of applications that, although otherwise unrelated, share a common need for methods capable of enhancing pictorial information for huma n interpretation and analysis .These applications include: remote sensing; security monitor in g;medical diagnosis ; automatic inspection; radar; sonar; detection of military targets; robotics; business communication; television enhancement ; etc.

Graphology:

*Graphology*is the analysis of the physical characteristics and patterns of handwriting purporting to be able to identify the writer, indicating psychological state at the time of writing, or evaluating personality.

The word Graphology is derived from *grapho*- (from the Greek γραφή, "writing") and *logos* (from the Greek λόγος, which relates to discussion or theory).

Graphology is a blend of art and science. It is a *science* because it measures the structure and movement of the written forms – *slants,angles* and *spacing* are accurately calculated and the pressure is observed in magnification and with precision. And it is an ***art*** because the graphologisthas to constantly keep in mind the total context in which the writing is taking place: the gestalt of the writing as a whole.

Graphotherapy:
Graphotherapy is a form of reverse psychology accomplished through handwriting exercises specifically designed to bring about more desirable personality traits. By doing these exercises you are accomplishing a gradual regrooving or retraining of your subconscious mind.
Graphotherapy works with the subconscious to make changes to those personality traits. You may think how you write is a conscious choice, after all when you choose to do your best writing, it looks different from the quick scrawl you make as you take notes from a phone call.

How does graphotherapy work?
Each stroke you make means something. It connects to a personality trait, a habit, a way of being that is presently part of your personality make-up. Sometimes there is more than one stroke that indicates the same or very similar tendencies. To add all the ones you want and replace all the ones you don‘t want is the goal of graphotherapy.

APPLICATIONS AND LIMITATIONS OF GRAPHOLOGY:-
 Applications of Graphology:
There are many uses of handwriting analysis. Below are a few of the most popular applications we use today. They are:
• Dating and Socializing
• Employee hiring and human resources
• Police profiling
• Self improvement and professional speaking
• Councillor, therapist and coaching applications

LIMITATIONS OF HANDWRITING ANALYSIS:-
Below are a few of the limitations of Handwriting analysis:
 Handwriting does not reveal the AGE of the writer
 Handwriting does not reveal the Gender of the writer
 Handwriting does not reveal if the writer has written using left or the right hand or any other part of the body.
 Caste, religion, race, creed or religious preferences cannot be found in the handwriting.
 The future cannot be predicted with handwriting.

LIMITATIONS WHEN WE DO ANALYSIS USING IMAGE PROCESSING TECHNIQUES ARE:
Below are a few of the limitations when we do analysis using image processing technique:
 We cannot know the pressure of writing.
 Dealing with illegible writing is difficult.

IMAGE SEGMENTATION:

 Technically speaking, image segmentation refers to the decomposition of a scene into different components (thus to facilitate the task at higher levels such as object detection and recognition)
 Scientifically speaking, segmentation is a hypothetical middle-level vision task performed by neurons between low-level and high-level cortical areas
In Handwriting image segmentation digital handwriting is segmented into three different types of segments, i.e. word segmentation, letter segmentation and line segmentation, each used for different processing.

The need to have clear, neat handwriting is of utmost importance in today’s society. Communicating ideas, writing and signing checks, signing legal agreements, and other daily activities need clear handwriting that is legible by others. One may argue that technology can replace the need for handwriting. For example, paying bills is now available online. However, computers cannot be relied on for everything. One factor to consider is the technology gap. There are many homes and work places that do not have computers and there are many other instances in daily life when a computer is not readily available. ! Furthermore, as young children learn the writing process and how to formulate thoughts in writing, the use of technology may not be practical. The physical act of writing down one's thoughts is part of the cognitive process of learning to communicate through writing. A young child who has not yet learned these skills would not be able to transfer the skills to a word processing program. The outcome of this study provided evidence that using drill and fine motor ac-tivities together greatly improved the hand-writing of a second grader with dysgraphia. While Sam showed improvement over the eight weeks during the after school sessions, he had a hard time generalizing what he learned to his class work. His written work improved, but Sam continued to make a few letters the same way he did before the inter-vention. Over time, it is my hope that he will continue to generalize and remember how to write each letter. There were some limitations to this action research. One limitation was that the study used only one participant. The purpose of action research is to identify a problem within a classroom and address the problemstudy met this purpose of action research, the findings are not generalizable. However, other teachers can learn from this case study both in terms of knowledge regarding dysgraphia and options for intervention. Teachers who work with children struggling with handwriting can gain information and tech-niques to help guide handwriting remediation, even if the child is not diagnosed with a writ-ing disability. Students in all elementary grades could benefit from structured instruc-tion on handwriting and how to form letters.

In 2016, Abhishek Bal and RajibSaha[1] proposed an off-line handwritten document analysis through segmentation, skew recognition and writing pressure for cursive handwritten document. The proposed segmentation method is based on modified horizontal and vertical projection that can segment the text lines and words even if the presence of overlapped and multi-skewed text lines. Proposed work also present orthogonal projection based baseline recognition and normalization method as well as writing pressure detection method that can predict the personality of writer from the baseline and writing pressure.

3. Objective of the project

Dysgraphia is one of the major problems found in children. Though it is short term effect but if it goes untreated remains throughout life.
So, through this project we have tried to find out the similarity between the people suffering from this disease. Also to bring out the matching pattern and the personality characteristics of the personality.

The hand writing samples are collected from wide variety of people belonging to both economical stable family and also from weaker section of the society.
Samples were also collected from equal number of males and females.

The purpose is to chalk out the characteristics of the people suffering from dysgraphia and characteristics related to the disease.

4.System Design

SOFTWARES USED:

We have mainly used Microsoft Windows 8 as the platform for implementing the Handwriting Recognition System. Also we have used MATLAB as the coding platform to implement the system and depict the procedure of each step and display the corresponding output. The software requirements in the system building the process are as follows

- **Microsoft Windows 8:**
- **MATLAB:**

HARDWARE USED:

The following hardware components needed in combination to our system for successful handwriting analysis are described below:

- **Webcam/Digital Camera**
- **4 GB RAM**
- **Keyboard**
- **Mouse**
- **Monitor**

5.Methodology for implementation(formulations/Algorithm)

5.1 Algorithm for the system

Step 1. Take samples input collected
Step 2. Convert the image into gray image
Step 3. Convert the image into binary image
Step 4. Getting the size of the image
Step 5. Segment the image into lines → words → characters →
Step 6. Compare the characteristics properties
Step 7. Suggesting the result.

5.2 Algorithm for line segmentation

Step 1. Read the images iteratively
Step 2. Convert the image into gray image
Step 3. Convert the image into binary image
Step 4. Count and sum the pixel values row-wise fashion & store in 1D array
Step 5. Traverse the 1D array containing row-wise pixel count
    Step 5.1. if pixel count > 9 then
        Step 5.1.2 do till pixel count <9 , segment the region & display
            Step 5.1.2.1 Store that segmented part in a folder
Step 6. End

5.3 Algorithm for word segmentation

Step 1. Read the segmented lines image iteratively
Step 2. Set pixel= 255* no. Of rows
Step 3. Count and sum the pixel values column-wise fashion & store in 1D Step 4. Traverse from 1st column to last
Step 5. Traverse the 1D array containing column-wise pixel count
    Step 5.1. if pixel count not equal pixel then
        Step 5.1.2 do till pixel count = pixel, segment the word
            Step 5.1.2.1 Store that segmented part in a folder
Step 6. End

5.4 Algorithm for letter segmentation

Step 1. Read the segmented words image iteratively
Step 2. Set pixel= 255* (r-1)
Step 3. Count and sum the pixel values column-wise fashion & store in 1D Step 4. Traverse from 1st column to last
Step 5. Traverse the 1D array containing column-wise pixel count
    Step 5.1. if pixel count not equal pixel then
        Step 5.1.2 do till pixel count = pixel, segment the letter
            Step 5.1.2.1 Store that segmented part in a folder
Step 6. End

5.5 Algorithm for template matching

Step 1. Read the template image
Step 2. Read the target image
Step 3. Convert both the images into gray scale if they are in rgb format
Step 4. Find the mean of the template image
Step 5. Find the mean of the target image
Step 6. Subtract mean value from the template image matrix
Step 7. Subtract mean value from the target image matrix
Step 8. Find covariance between template and target image
Step 9. Co-relate the images and box the matching result

6.Implementation details

- Handwriting samples were collected from 50 people
- 30 were children of age group 6-15 years and 20 were of 15+ age
- Out of this 50, 25 were males and rest females
- We will use a digitizing tablet to acquire handwriting
- employ complex parameterization to quantify its kinematic aspects and

  hidden complexities.
- begins with collecting the handwriting samples on plain white A4 size paper
- perform preprocessing steps such as binarization and noise removal etc for better recognition
- color image or gray scale image is taken as an input then thresholding is done to convert the image into binary image

  1. To remove the noise from the image
  2. To get the better results
  3. For accuracy and correction purposes
- Then line segmentation, word segmentation and character segmentation have been performed
- After each segmentation process, the characteristics properties are matched.

6.1 Sample Collection

Handwriting samples of 50 children were collected and it was found that out of these 50 , 4 person were actually suffering from dysgraphia. This samples were taken on A4 sheets and considered further.

A group of School children live on the planet venus with their rocket men and women' Parents. The Sun Shines on the planet for only two hours. once every seven years and the Story opens on the day that the Sun is due to make its appearance once again. Margot come from earth to venus five years ago and like other children is excitedly awaiting the Sun. whatke

Just listen to the engine

Ans it pulls you with a will.

Though it goes so very slowly,

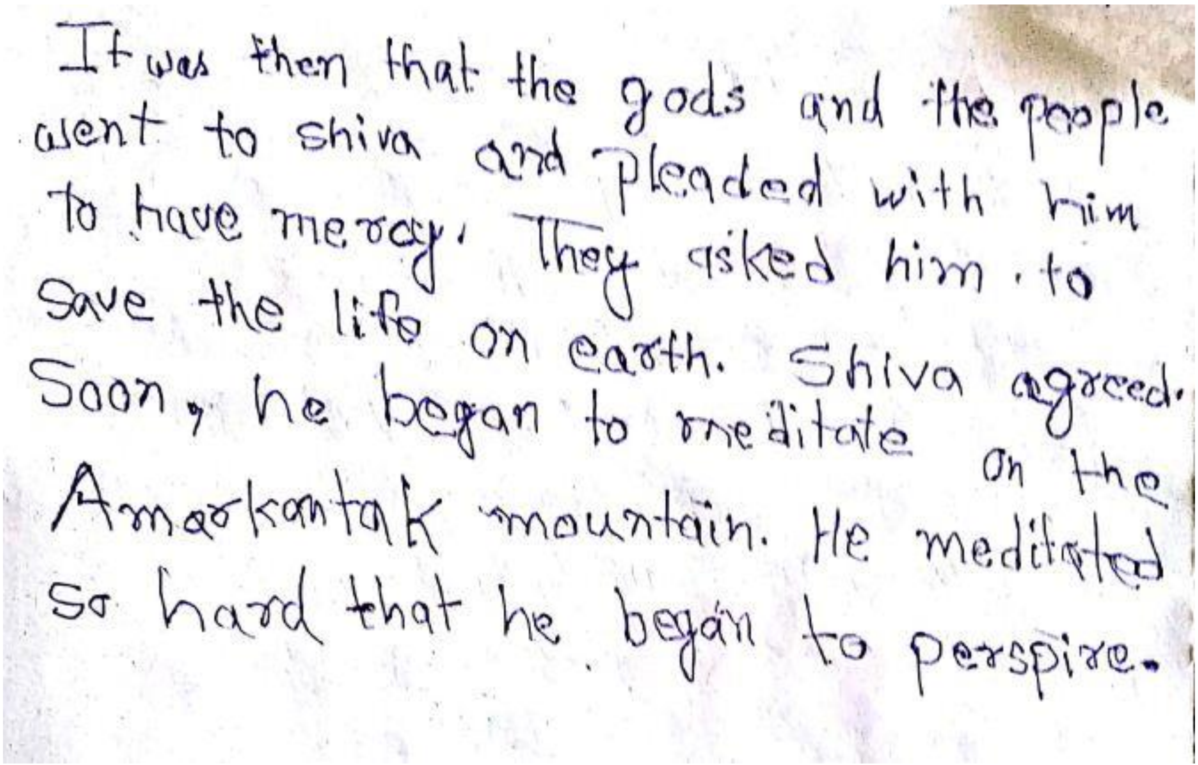
it sings this little song,

I think I can I think I can,

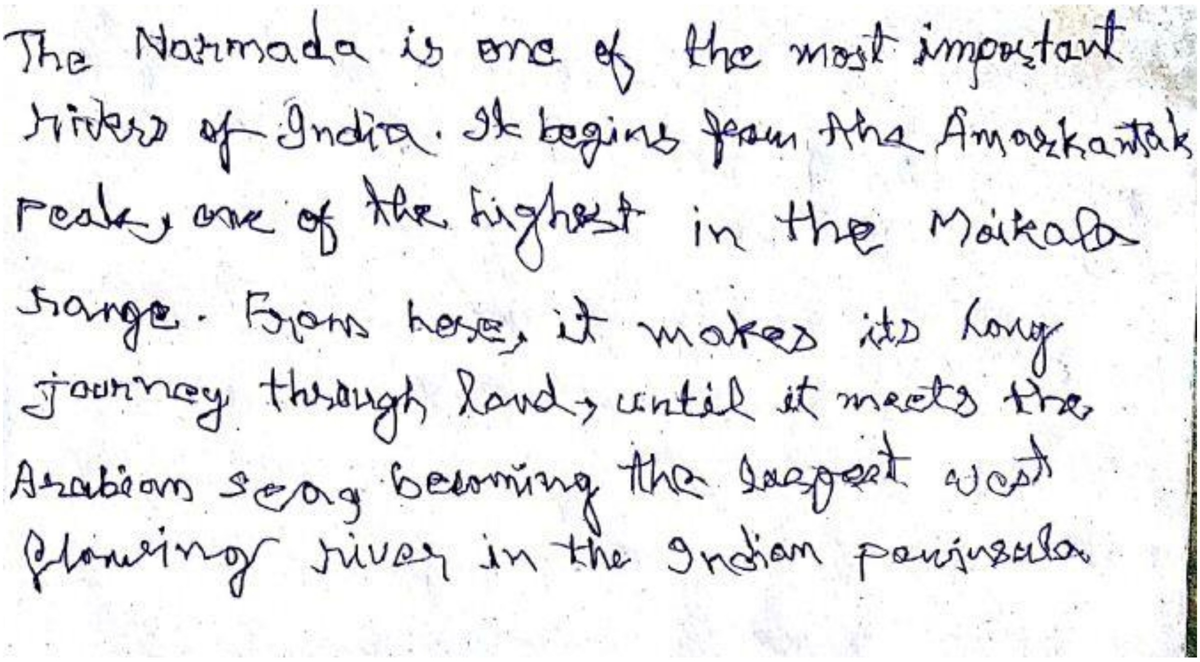
And so it goes along

The children from the Village who brought their Colours to gaze on the grass. That grew on the ruins, noticed the stones. They saw the large mounds and the way. "It looks like a king's seat!" Another boy quickly invented a game to fit the situation. "Let's play at having trials, " he suggested. "I'll sit on the mound and be the judge and solve you quarrels.

So one evening, Don Quixote and Sancho Panza rode out of the village. They rode all night. Sancho sat upright on his donkey. His leather-bottle was full of water and his empty saddlebags were ready to receive the things that they would win in their contests.



It was then that the gods and the people went to shiva and pleaded with him to have mercy. They asked him to save the life on earth. Shiva agreed. Soon, he began to meditate on the Amarkantak mountain. He meditated so hard that he began to perspire.



The Narmada is one of the most important rivers of India. It begins from the Amarkantak peak, one of the highest in the Maikala range. From here, it makes its long journey through land, until it meets the Arabian sea becoming the largest west flowing river in the Indian peninsula

6.2 Image Pre-processing

Image pre-processing [1] is the technique in which the handwritten sample is translated into a format which can be easily and efficiently processed in further steps. These steps involve binarization, noise removal, line segmentation, word segmentation and skew normalization. Binarization converts gray scale image into binary image. Quality of the converted image is improved by applying noise removal techniques**.**

6.3 Line Segmentation

After binarization and noise removal, the converted image is processed through a line segmentation [1] technique to split the hand-written document into separate lines based on rising section of the horizontal projection histogram of document image.

6.4 Word Segmentation

In the case of word segmentation [1], to segment, the words from the line, firstly inter-word and intra-word gaps are measured. Inter-word gaps denote the gaps between two words and intra-word gaps denote gaps within a word. Generally, gaps between the words are larger than the gaps within a word. These proposed methods construct the vertical projection histogram to measure the width of each inter-word and intra-word gaps then it measures the threshold value to differentiate between inter-word and intra-word gaps. If the width of gaps is greater than or equals to threshold then gaps are treated as inter-word gaps and words are segmented individually from the line depending on the threshold.If a line has global skew then it may possible that several words within a line may have different skew. So, it may require normalizing the skew of the words for a single line. For that reason, again skew normalization method is applied to each segmented word separately.

6.5Code for line segmentation

```
clc
clear
files=dir('G:\matlab\work\final\images\*.jpg');
line=1;
img1=zeros(1000,1000);
while (line<=length(files))
filename=strcat('G:\matlab\work\final\images\',files(line
).name);
    a=imread(filename);
    g= rgb2gray(a);
minimum=min(g(:));
maximum=max(g(:));
med=(minimum+maximum)/2;
    [rows, col]=size(g);
fori=1:rows
for j=1:col
if g(i,j)>= med
img1(i,j)=1;
else
img1(i,j)=0;
end
end
end
imshow(img1);
% pause

    p=zeros(rows,1);
fori=1:rows
p(i,1)=col - sum(img1(i,:));
end
```

```
fori=1:rows
if(p(i,1)>9)

for  j=i+1:rows

if(p(j,1)<9)

break;
end
end
imshow(img1(i:j-1,:));

end

end

end
```

6.6 code for word segmentation

```
files=dir('G:\matlab\work\final\lines\*.jpg');

word_no=1;
line=1;
while (line<=length(files))
filename=strcat('G:\matlab\work\final\lines\',files(line)
.name);
    z1=imread(filename);
%figure,
%imshow(z1);

    [r, c]=size(z1);
pixel=255*r;
    q=zeros(c,1);

for j=1:c

q(j,1)= sum(z1(1:r,j));

end

    f=1;
while(f<=c)
```

```
if(q(f,1)~=pixel)
for g=f:c
if (q(g,1)==pixel)
break;
end
end
word_img=(z1(:,f:g-1));
figure,
imshow(word_img);

filename=sprintf('word%d.jpg',word_no);
path=strcat('G:\matlab\work\final\words\',filename);
imwrite(word_img,path);
            f=g-1;
word_no=word_no+1;
end
        f=f+1;
end
line=line+1;
end
```

6.7 code for letter segmentation

```
files=dir('G:\matlab\work\final\chars\*.jpg');

no=1;
line=1;
while (line<=length(files))
filename=strcat('G:\matlab\work\final\chars\',files(line)
.name);
    a=imread(filename);
%a=imread('G:\matlab\work\char_test\word10.jpg');
%imshow(a)
    [r,c]=size(a);
cs=zeros(c,1);
fori=1:c
cs(i,1)=sum(a(:,i));
end

i=1;
while(i<=c)
if(cs(i,1)<8350)

for  j=i+1:c

if(cs(j,1)>8350)
```

```
break;
end
end


imgs=(a(:,i:j-1));
figure,
imshow(imgs)
filename=sprintf('char%d.jpg',no);
path=strcat('G:\matlab\work\final\chars\',filename);
imwrite(imgs,path);
no=no+1;
i=j-1;  %increment the value to starting of the  next
line
end
i=i+1;
end
line=line+1;
end
```

6.8 code for template matching

6.8.1 main

```
im1=imread('G:\matlab\work\final\char\word92.jpg');
im2=imread('G:\matlab\work\final\char\wordd14.jpg');

result1=tmp(im1,im2);

figure,
subplot(2,2,1),imshow(im1);title('Template');
subplot(2,2,2),imshow(im2);title('Target');
subplot(2,2,3),imshow(result1);title('Matching Result
within black box');
```

6.8.2 template-target matching

```
function result=tmc(image1,image2)
if size(image1,3)==3
    image1=rgb2gray(image1);
end
if size(image2,3)==3
    image2=rgb2gray(image2);
end

% check which one is target and which one is templete

if size(image1)>size(image2)
```

```
    Target=image1;
    Template=image2;
else
    Target=image2;
    Template=image1;
end
% read both images sizes
[r1,c1]=size(Target);
[r2,c2]=size(Template);

% mean of the template
image22=Template-mean(mean(Template));

%corrolate both images
corrMat=[];
fori=1:(r1-r2+1)
for j=1:(c1-c2+1)
Nimage=Target(i:i+r2-1,j:j+c2-1);
Nimage=Nimage-mean(mean(Nimage));  % mean of image part
under mask
corr=sum(sum(Nimage.*image22));
corrMat(i,j)=corr;
end
end

% plot box on the target image
result=plotbox(Target,Template,corrMat);
```

6.8.3 plotting box

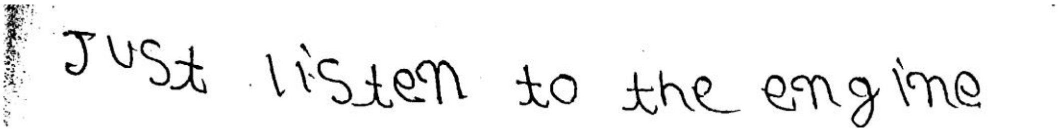
```
function result=plotbox(Target,Template,M);

[r1,c1]=size(Target);
[r2,c2]=size(Template);

[r,c]=max(M);
[r3,c3]=max(max(M));

i=c(c3);
j=c3;
result=Target;
for x=i:i+r2-1
for y=j
result(x,y)=00;
end
end
```

```
for x=i:i+r2-1
for y=j+c2-1
result(x,y)=00;
end
end
for x=i
for y=j:j+c2-1
result(x,y)=000;
end
end
for x=i+r2-1
for y=j:j+c2-1
result(x,y)=000;
end
end
```

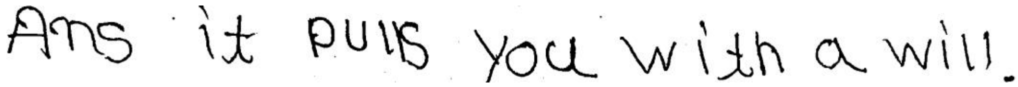
7.Sample output and result

7.1 Segmentated Lines sample

1.

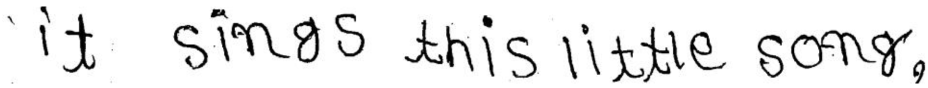


2.

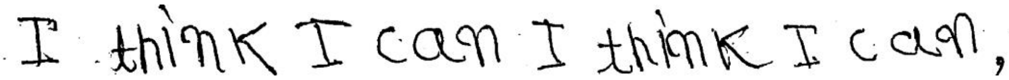


3.

4.



5.



6.

7.

7.2 segmentated word samples

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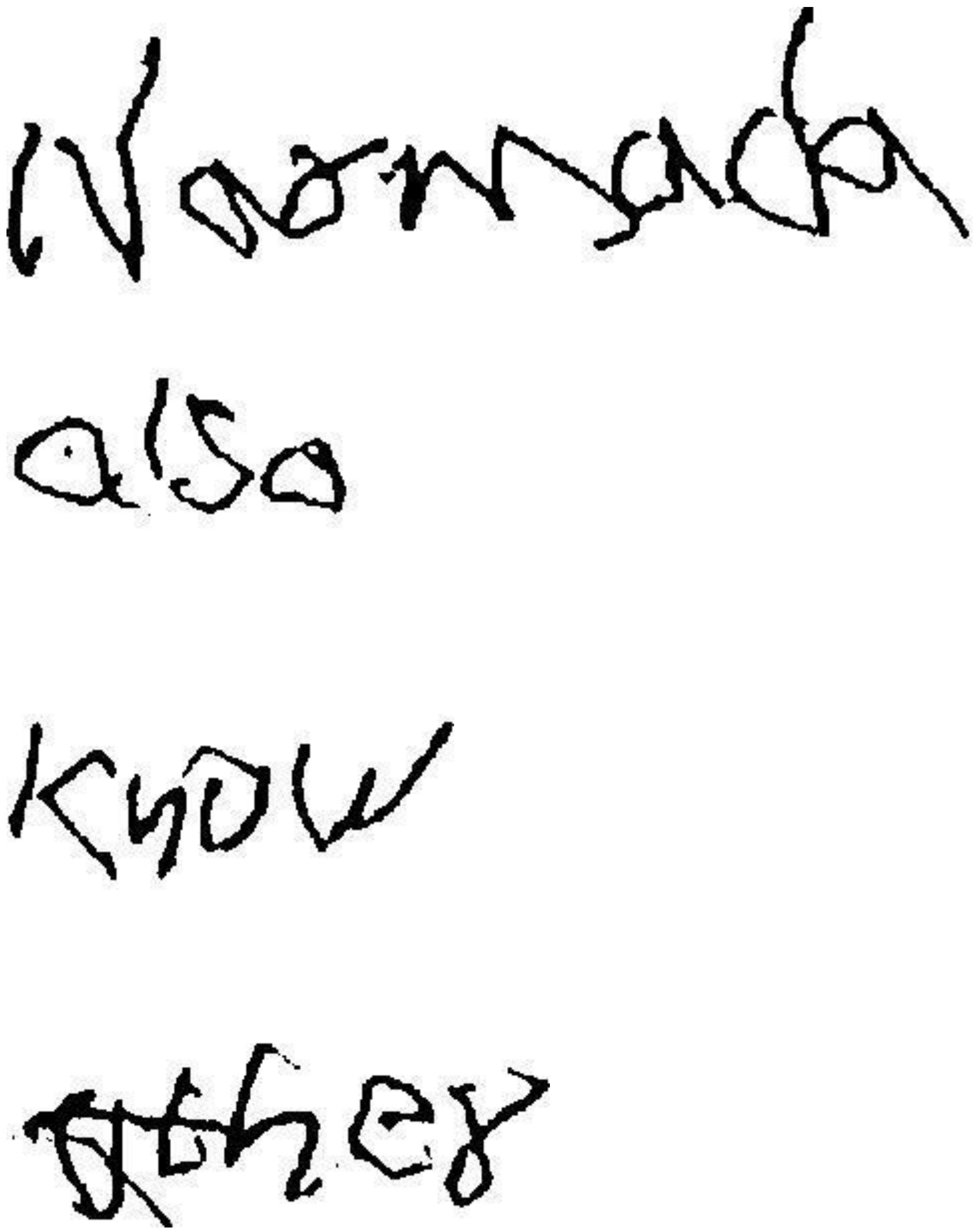
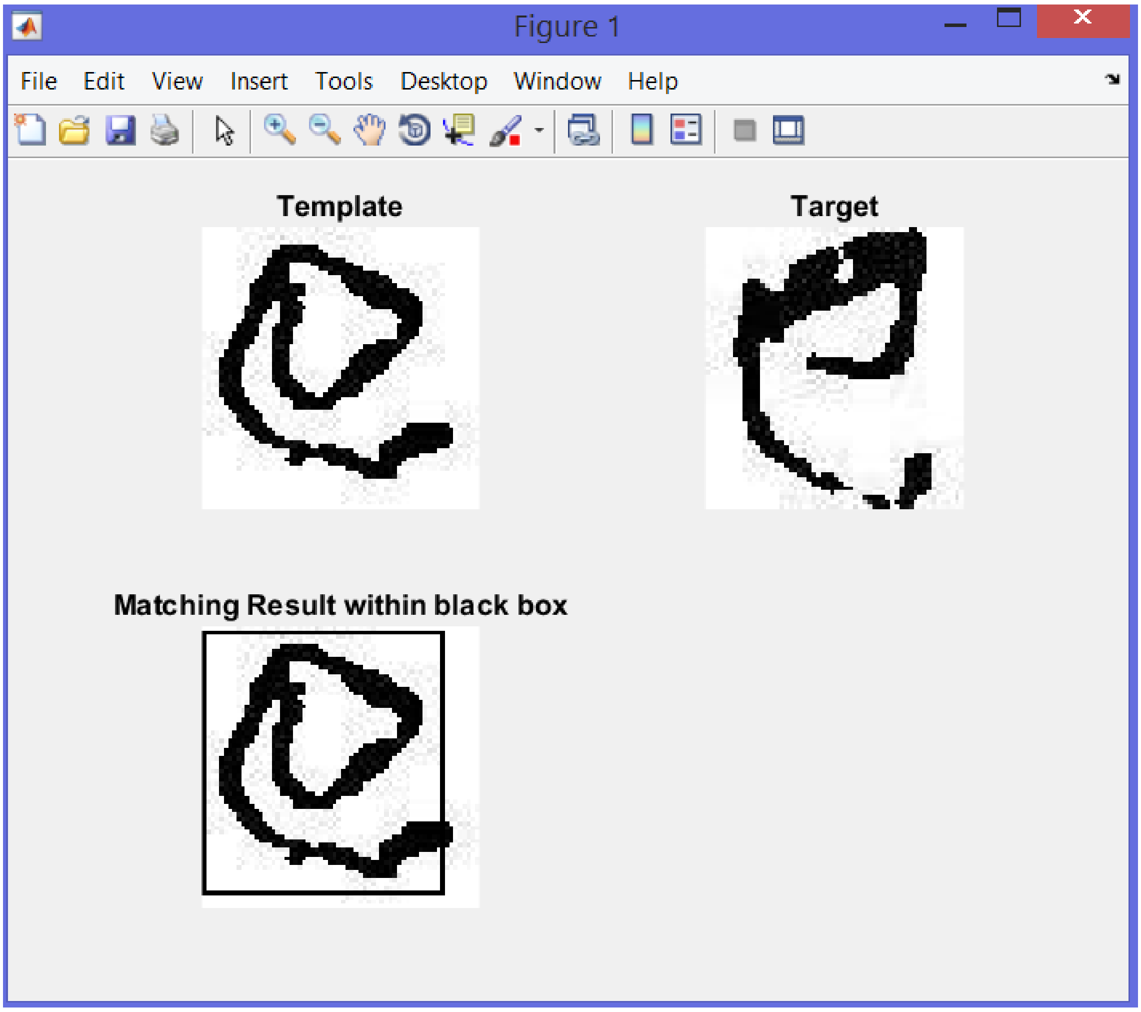


7.3 letter segmentation result

7.4 template matching results



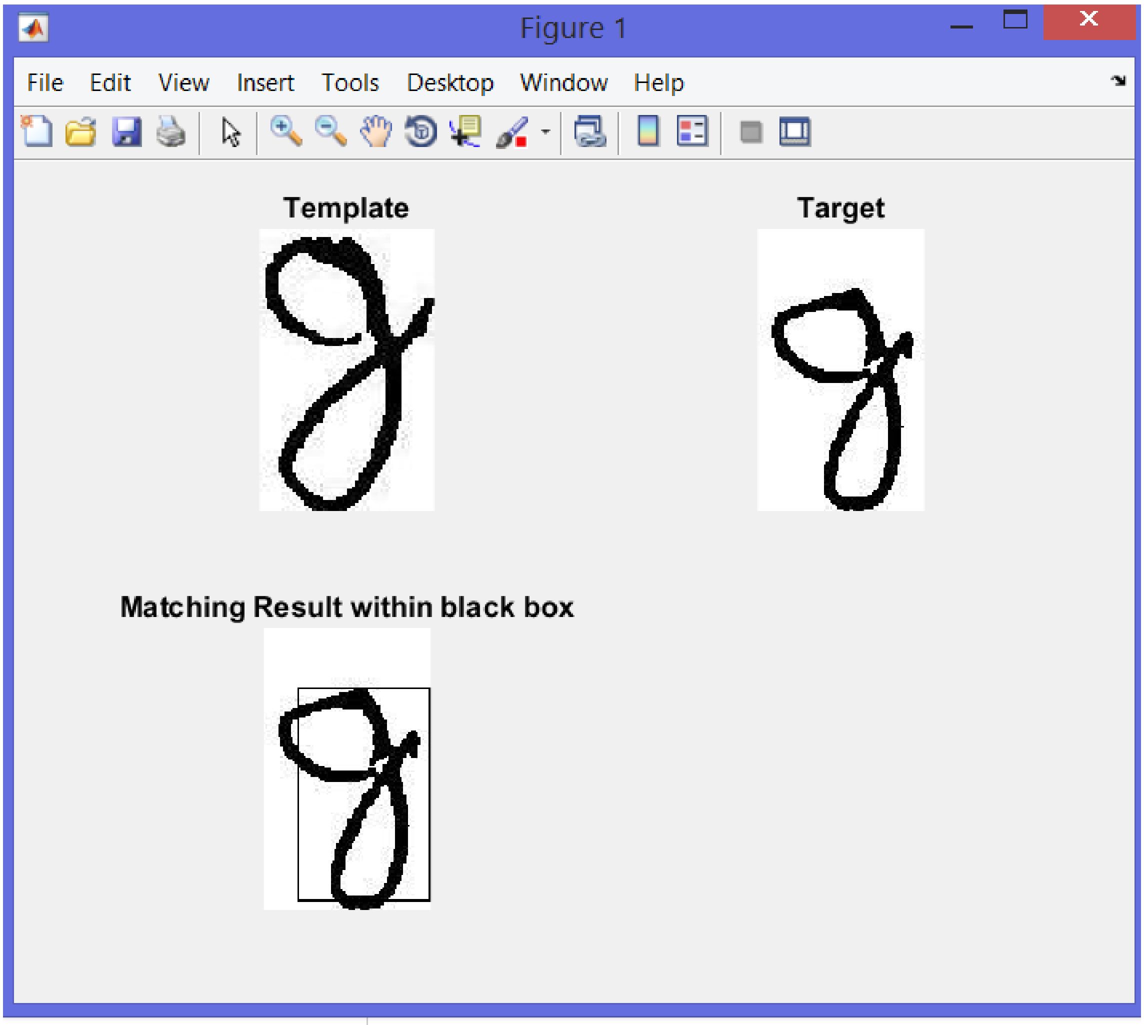


Figure 1
File Edit View Insert Tools Desktop Window Help
Template
Target
Matching Result within black box

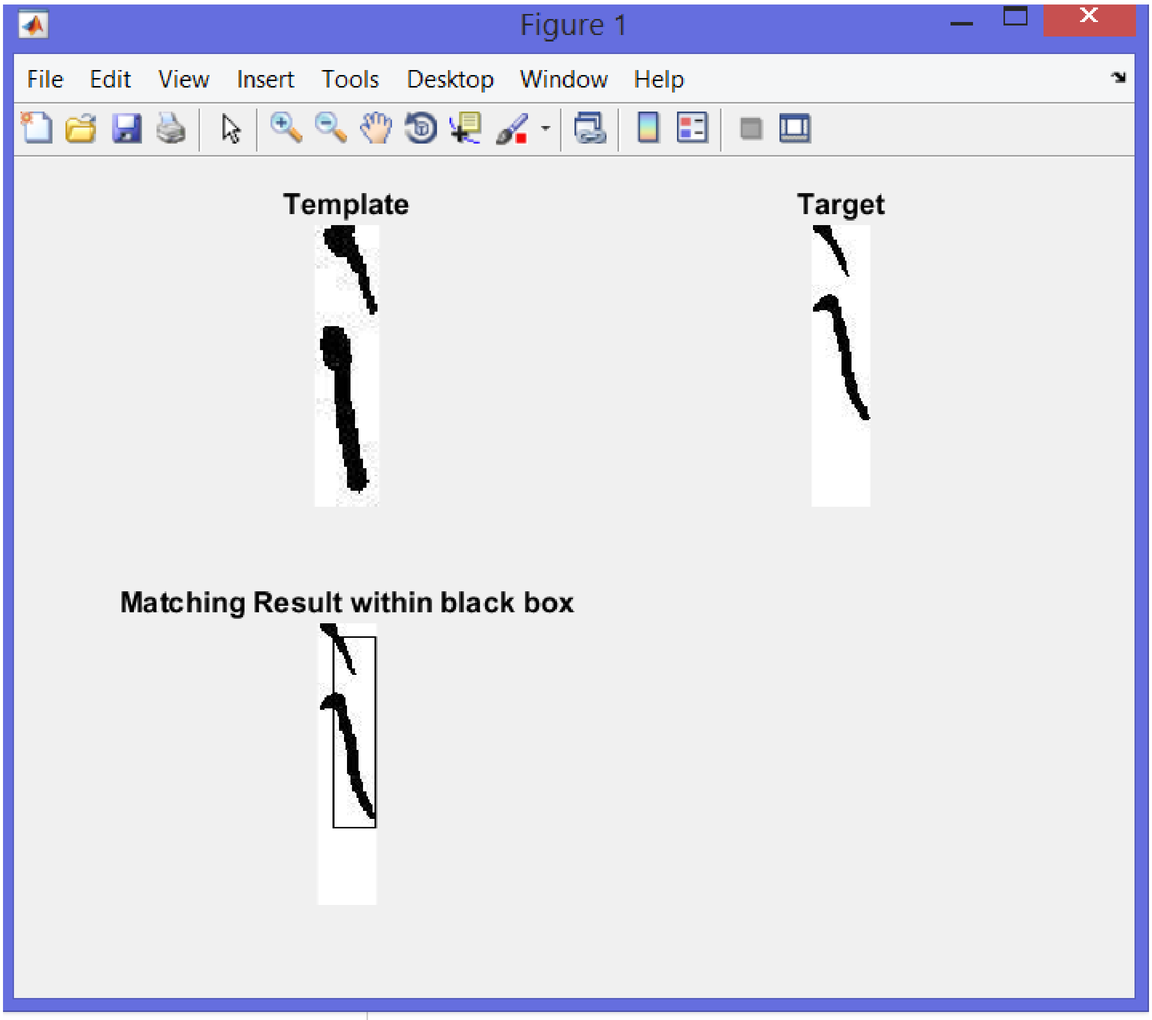


Figure 1
File Edit View Insert Tools Desktop Window Help
Template
Target
Matching Result within black box

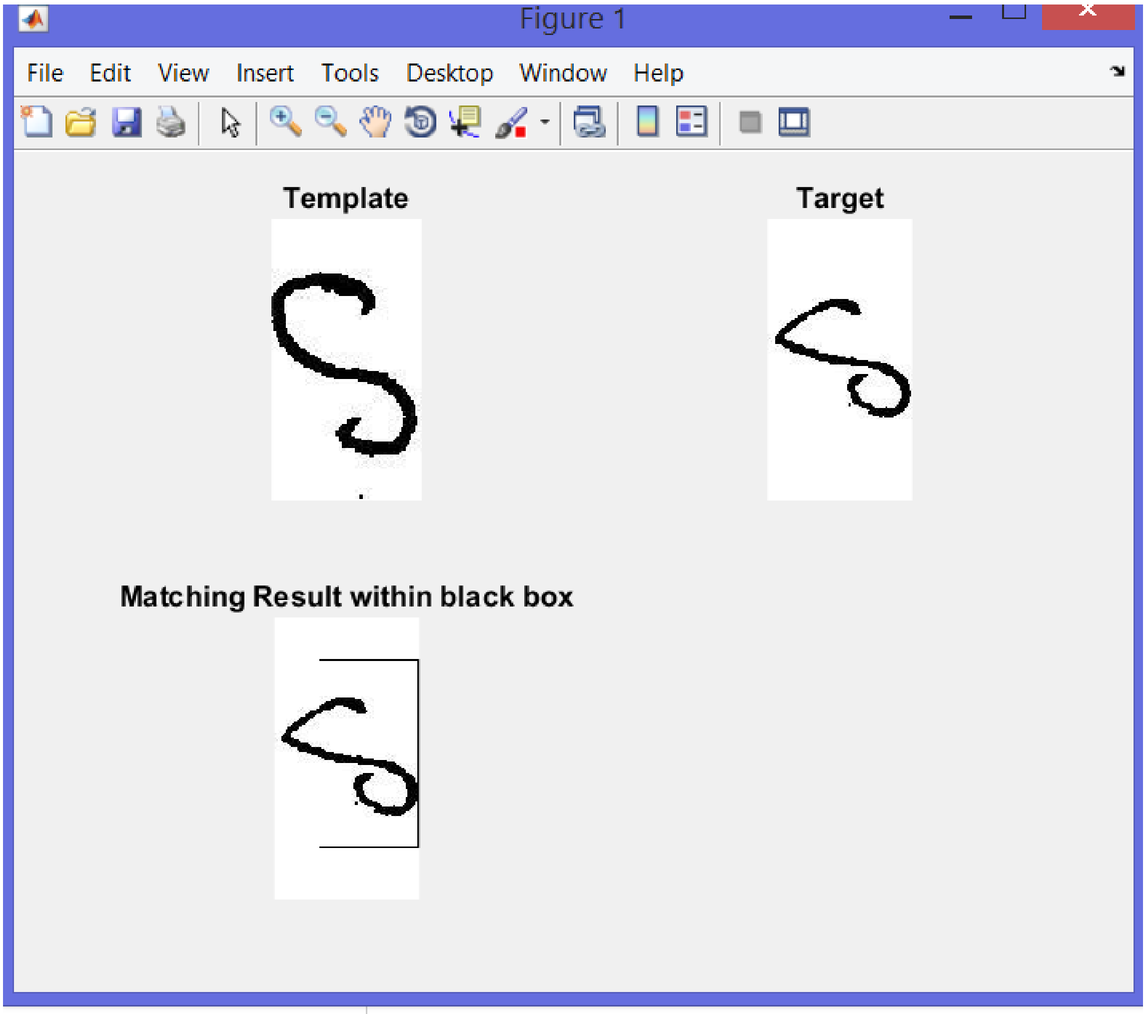
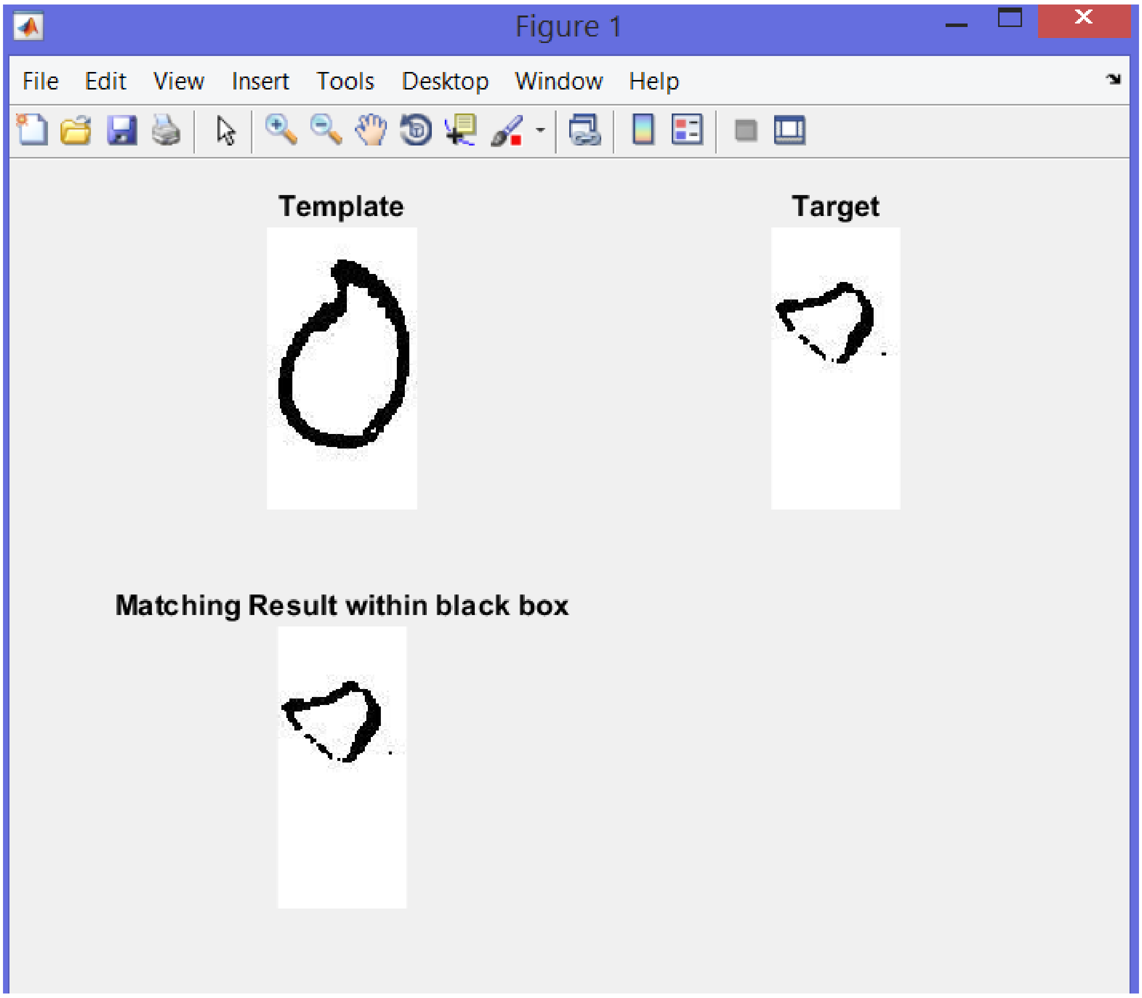


Figure 1
File Edit View Insert Tools Desktop Window Help
Template
Target
Matching Result within black box



Unmatched data

Results Observed

Letter	Observed style	Imposed characterstics
e	Floating tail, curved head	Uninfluenced by emotions
i	Left slanted	Reserved & introspect
G	Squeezed and curved	Selective in nature
S	backward tilted, narrow bottom	Holding aggression

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8. Conclusion

So, this results signify that people with Dysgraphia or tending to get dysgraphia will have the above mentioned characteristics with the similarity in the pattern. But it is does not in any case tell that a person not having dysgraphia will not show this properties.

Of the 50 peoples sample collected, 4 people showed signs of dysgraphia. Among this 4, 3 were children belonging to age group of 6-15 years.

The results also show that dysgraphia has no connection with the gender of that person. It can happen to both male and female.

Also, of this 4 people, 3 belonged to the economically stable family and the other person was from lower middle class family.

So we can say that dysgraphia has nothing to do with the economic status of the family from which the person belong.

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